FERC SP-G2
DRAFT Erosion Site Description and Analysis Summary

SUMMARY:

The Department of Water Resources (DWR), Central District, completed a general description and analysis of erosion sites based on the requirements of the Oroville Dam FERC relicensing project SP-G2. General site locations were selected by DWR, Northern District.

For each site, a general description, a spreadsheet detailing the erosion site calculations, and a map are provided. The general descriptions (below) describe the site location, the maximum erosion rates for both pre- and post-construction of the Oroville Dam (1967), special factors affecting erosion at the site, and the relative accuracy of the photomosaic image correlation. Erosion site calculations are based on the comparison of erosional features as interpreted from surveys and aerial photographs. The maps provide a time sequence series of surveys and images from 1909, 1956 or 1962, 1967, 1986, and 1998 with overlaid line work detailing the erosional cut banks and water's edge at the selected erosion site.

The results from this analysis include calculations of maximum erosion rates (summarized below) and average erosion rates per foot of cut bank (shown on each spreadsheet). The maximum erosion rate is calculated by measuring the maximum distance between cut banks for two selected photosets, which is then divided by the number of months elapsed between the time the photosets were captured. The resulting number is converted and expressed as feet per year. The average erosion rate per foot of cut bank is calculated by computing the area between cut banks for two selected photosets, dividing this area by the average length of the cut banks, which is then divided by the number of months elapsed between the time the photosets were captured. The resulting number is converted and expressed as acres per foot per year.

PROCEDURES:

Before completing the erosion site analysis as described below, all necessary background imagery and line work was loaded into an AutoCAD Map project drawing. Analysis of erosion at a specific site include the following steps:

a) Determine the general location of the erosion site by river mile (RM)
   - note general features of site

b) Determine the accuracy of the correlation of the photomosaics to the 1998 digital ortho quarter quad (DOQQ)
    - note distance and general direction each photomosaic varies from the 1998 DOQQ photoset by comparing similar points of reference for different years
    - make adjustments if necessary
    - note any required adjustments

c) Delineate the erosional (cut) bank at the general erosion site for each study year by digitizing lines interpreted from the aerial photos
    - note any complications with digitizing the cut bank

d) Digitize levees or other structures controlling the erosion at the site

e) Determine the specific upstream and downstream boundaries of the erosion site by critical examination of the river water's edge, erosional banks, and aerial photos
    - when logical, draw the boundary (erosion site) lines perpendicular to the river channel extending across all water's edge and cut bank lines to delineate the upstream and downstream edge for area calculations
    - otherwise, draw the boundary across all water's edge and cut bank lines to delineate the upstream and downstream edge for area calculations (note – these lines are not necessarily straight)

f) Create polygon regions using erosional bank delineations from two aerial photo years and the upstream and downstream site boundaries

g) Calculate the length of each erosional bank between the upstream and downstream site boundaries (express as feet)

h) Calculate the area within each created polygon (express as acres and square feet)

i) Plot and measure the maximum width and direction of erosion for both pre-dam (1909 to 1967) and post-dam (1967 to 1998) time periods (express width in feet and direction as azimuth). Calculate the maximum erosion rate (express as feet/month and feet/year) by dividing the maximum erosion width by the number of months for each time period

j) Plot each site as a .pdf at 11"x17" at a scale of 1" = 1000' where possible

k) Include in each plot:
    - a 1909 base map with 1967 and pre-1967 cut bank lines and hatching. The 1967 line should be thicker to indicate that it is the pre-dam/post-dam reference line
    - a 1967 base photo with 1909, 1967, and 1998 cut bank lines and hatching. The 1967 line should be thicker to indicate that it is the pre-dam/post-dam reference line
    - a 1998 base photo with 1967 and post-1967 cut bank lines and hatching. The 1967 line should be thicker to indicate that it is the pre-dam/post-dam reference line
    - a title, legend, scale, and north arrow

FERC SP-G2: Erosion Site Description and Analysis Summary

Site Name: RM 28.6

Site location: Between RM 28.8 and 28.2 along the river-left bank on a right-handed bend.

Erosion Calculation Summary:

Pre-Dam Construction:

Maximum erosion width: 705 ft

Average erosion rate: 12 ft/year

Post-Dam Construction:

Maximum erosion width: 364 ft

Average erosion rate: 11 ft/year

Description: Pre-dam analysis years: This time interval is characterized by periods of erosion (1909-1956) and periods of aggradation (1956-1967). Maximum pre-dam erosion occurs within the upstream half of the site.

Post-dam analysis years: This time interval is predominantly characterized by varying degrees of erosion. Maximum post-dam erosion occurs just downstream from the measured pre-dam erosion maximum and within the middle of the site.

Notes on accuracy of image correlation: No adjustment to the images was necessary. Approximate image accuracy (compared with 1998 DOQQ images) is listed below. Distances are approximate and indicate the length and direction the indicated photomosaic varies from the 1998 DOQQ:

YEAR	DISTANCE	DIRECTION
1909	0 m	-
1956 / 1962	8 m	SE
1967	13 m	N
1986	4 m	NW

FERC SP-G2: Erosion Site Description and Analysis Summary

Site Name: RM 33.5

Site location: Between RM 33.65 and 33.41 along the river-right bank on a left-handed bend.

Erosion Calculation Summary:

Pre-Dam Construction:

Maximum erosion width: 225 ft

Average erosion rate: 4 ft/year

Post-Dam Construction:

Maximum erosion width: 97 ft

Average erosion rate: 3 ft/year

Description: Pre-dam analysis years: 1909-1956 is characterized predominantly by erosion, with only minor aggradation; 1956-1967 is characterized by both erosion (occurring at the downstream portion of the site) and aggradation (occurring at the upstream portion of the site). Aggradation accounts for about 60 percent of the total change in channel area during the 1956-1967 time period. Maximum pre-dam erosion occurs within the upstream half of the site.

Post-dam analysis years: 1967-1986 is characterized by both erosion (occurring at the downriver portion of the site) and aggradation (occurring at the upstream portion of the site); aggradation accounts for about 45 percent of the total change in channel area during this time period. 1986-1998 is a period characterized by very little change, with only minor erosion and even less aggradation. Maximum post-dam erosion occurs within the downstream half of the site.

Notes on accuracy of image correlation: No adjustment to the images was necessary. Approximate image accuracy (compared with 1998 DOQQ images) is listed below. Distances are approximate and indicate the length and direction the indicated photomosaic varies from the 1998 DOQQ:

YEAR	DISTANCE	DIRECTION
1909	7 m	W
1956 / 1962	6 m	SE
1967	7 m	N
1986	7 m	NW

FERC SP-G2: Erosion Site Description and Analysis Summary

Site Name: RM 34.0

Site location: Pre-dam: Between RM 34.53 and 33.62 along the river-left bank on a right-handed bend. Post-dam: Between RM 34.47 and 33.50 along the river-left bank on a right-handed bend.

Erosion Calculation Summary:

Pre-Dam Construction:

Maximum erosion width: 482 ft

Average erosion rate: 8 ft/year

Post-Dam Construction:

Maximum erosion width: 743 ft

Average erosion rate: 23 ft/year

Description: The nature of this river bend is complex due to its proximity to a river bend and an erosion site, both immediately upstream and downstream from the site. As a result, there is some overlap between the erosional and/or aggradational bank boundaries between these "linked" river bends. To resolve the issue of overlapping bank boundaries between the adjacent river bends, it was necessary to select two different site boundaries for the site, which correspond to the two different time periods studied (pre-dam and post-dam).

Pre-dam analysis years: 1909-1967 is characterized predominantly by erosion, with only minor aggradation (accounting for less than 5 percent of the total change in channel area). Pre-dam erosion occurs at a relatively uniform rate and along the entire length of the site. The measured maximum erosion occurs within the downstream half of the site.

Post-dam analysis years: 1967-1998 is characterized predominantly by erosion, with only minor aggradation (accounting for less than 1 percent of the total change in channel area). Measured maximum erosion occurs within the upstream half of the site.

Site Name: RM 34.0 (Continued)

Notes on accuracy of image correlation: No adjustment to the images was necessary. Approximate image accuracy (compared with 1998 DOQQ images) is listed below. Distances are approximate and indicate the length and direction the indicated photomosaic varies from the 1998 DOQQ:

YEAR	DISTANCE	DIRECTION
1909	7 m	W
1956 / 1962	6 m	SE
1967	7 m	N
1986	7 m	NW

FERC SP-G2: Erosion Site Description and Analysis Summary

Site Name: RM 34.5

Site location: Pre-dam: Between RM 34.90 and 34.38 along the river-right bank on a left-handed bend. Post-dam: Between RM 34.78 and 34.25 along the river-right bank on a left-handed bend.

Erosion Calculation Summary:

Pre-Dam Construction:

Maximum erosion width:	1,020 ft
Average erosion rate:	18 ft/year

Post-Dam Construction:

Maximum erosion width:	682 ft
Average erosion rate:	22 ft/year

Description: The nature of this river bend is complex due to its proximity to a river bend and an erosion site, both immediately upstream and downstream from the site. As a result, there is some overlap between the erosional and/or aggradational bank boundaries between these "linked" river bends (for some years). To resolve the issue of overlapping bank boundaries between the adjacent river bends, it was necessary to select two different site boundaries for the site, which correspond to the two different time periods studied (pre-dam and post-dam).

Pre-dam analysis years: While the 1909 channel is only slightly curved, the subsequent pre-dam analysis years (1956 and1967) show a much more pronounced river bend and suggest a meandering channel is present. 1909-1956 is characterized entirely by erosion; 1956-1967 is characterized by both erosion (occurring at the downstream portion of the site) and aggradation (occurring at the upstream portion of the site, and accounting for about 26 percent of the total change in channel area). Measured maximum erosion occurs within the downstream half of the site.

Post-dam analysis years: 1967-1998 is characterized predominantly by erosion, with only minor aggradation (accounting for about 1 percent of the total change in channel area). During this time period, the stream channel (bend) is noted to migrate in the downriver direction. Measured maximum erosion occurs within the downstream half of the site.

Site Name: RM 34.5 (Continued)

Notes on accuracy of image correlation: No adjustment to the images was necessary. Approximate image accuracy (compared with 1998 DOQQ images) is listed below. Distances are approximate and indicate the length and direction the indicated photomosaic varies from the 1998 DOQQ:

YEAR	DISTANCE	DIRECTION
1909	7 m	W
1956 / 1962	6 m	SE
1967	7 m	N
1986	7 m	NW

FERC SP-G2: Erosion Site Description and Analysis Summary

Site Name: RM 35.0

Site location: Pre-dam: Between RM 35.39 and 34.91 along the river-left bank on a right-handed bend. Post-dam: Between RM 35.45 and 34.79 along the river-left bank on a right-handed bend.

Erosion Calculation Summary:

Pre-Dam Construction:

Maximum erosion width: 1,088 ft

Average erosion rate: 19 ft/year

Post-Dam Construction:

Maximum erosion width: 278 ft

Average erosion rate: 9 ft/year

Description: The nature of this river bend is complex due to its proximity to a river bend, both immediately upstream and downstream from the site. As a result, there is some overlap between the erosional and/or aggradational bank boundaries between these "linked" river bends (for some years). To resolve the issue of overlapping bank boundaries between the adjacent river bends, it was necessary to select two different site boundaries for the site, which correspond to the two different time periods studied (pre-dam and post-dam).

Pre-dam analysis years: 1909-1967 is characterized predominantly by erosion, which occurs at a relatively uniform rate; aggradation accounts for less than 8 percent of the total change in channel area during this time period. Measured maximum erosion occurs at about the midpoint of the site.

Post-dam analysis years: 1967-1998 is characterized predominantly by erosion, which occurs at a non-uniform rate; aggradation accounts for less than 1 percent of the total change in channel area during this time period. Measured maximum erosion occurs at about the midpoint of the site.

Site Name: RM 35.0 (Continued)

Notes on accuracy of image correlation: No adjustment to the images was necessary. Approximate image accuracy (compared with 1998 DOQQ images) is listed below. Distances are approximate and indicate the length and direction the indicated photomosaic varies from the 1998 DOQQ:

YEAR	DISTANCE	DIRECTION
1909	7 m	W
1956 / 1962	6 m	SE
1967	7 m	N
1986	7 m	NW

FERC SP-G2: Erosion Site Description and Analysis Summary

Site Name: RM 44.0

Site location: Between RM 44.35 and 43.64 along the river-left bank on a right-handed bend.

Erosion Calculation Summary:

Pre-Dam Construction:

Maximum erosion width: 533 ft

Average erosion rate: 9 ft/year

Post-Dam Construction:

Maximum erosion width: 533 ft

Average erosion rate: 17 ft/year

Description: Pre-dam analysis years: 1909-1967 is characterized predominantly by erosion, which occurs at a non-uniform rate; aggradation accounts for less than 5 percent of the total change in channel area during this time period. Measured maximum erosion occurs within the upstream half of the site.

Post-dam analysis years: 1967-1998 is characterized predominantly by erosion, which occurs at a non-uniform rate; aggradation accounts for less than 1 percent of the total change in channel area during this time period. Measured maximum erosion occurs at about the midpoint of the site.

Notes on accuracy of image correlation: No adjustment to the images was necessary. Approximate image accuracy (compared with 1998 DOQQ images) is listed below. Distances are approximate and indicate the length and direction the indicated photomosaic varies from the 1998 DOQQ:

YEAR	DISTANCE	DIRECTION
1909	7 m	W
1956 / 1962	4 m	W
1967	11 m	W
1986	7 m	W

FERC SP-G2: Erosion Site Description and Analysis Summary

Site Name: RM 44.4

Site location: Between RM 44.60 and 44.30 along the river-right bank on a right-handed bend.

Erosion Calculation Summary:

Pre-Dam Construction:

Maximum erosion width: 320 ft

Average erosion rate: 6 ft/year

Post-Dam Construction:

Maximum erosion width: 344 ft

Average erosion rate: 11 ft/year

Description: Pre-dam analysis years: 1909-1967 is characterized predominantly by erosion, which occurs at a non-uniform rate; aggradation accounts for about 26 percent of the total change in channel area during this time period. Measured maximum erosion occurs at the midpoint of the site.

Post-dam analysis years: 1967-1998 is characterized predominantly by erosion, which occurs at a non-uniform rate; aggradation accounts for about 7 percent of the total change in channel area during this time period. Measured maximum erosion occurs at about the midpoint of the site.

Notes on accuracy of image correlation: No adjustment to the images was necessary. Approximate image accuracy (compared with 1998 DOQQ images) is listed below. Distances are approximate and indicate the length and direction the indicated photomosaic varies from the 1998 DOQQ:

YEAR	DISTANCE	DIRECTION
1909	7 m	W
1956 / 1962	4 m	W
1967	11 m	W
1986	7 m	W

FERC SP-G2: Erosion Site Description and Analysis Summary

Site Name: RM 45.0

Site location: Between RM 44.8 and 45.4 along the river-left bank upstream of a left-handed bend.

Erosion Calculation Summary:

Pre-Dam Construction:

Maximum erosion width: 455 ft

Average erosion rate: 8 ft/yr

Post-Dam Construction:

Maximum erosion width: 619 ft

Average erosion rate: 13 ft/yr

Description: Erosion at this site reversed the direction of the meander bend from a left-hand to a right-hand curve. The Debris Commission Survey in 1909 indicates that the erosional bank was on the river-right side; however, subsequent aerial photos indicate a shift in the erosional bank from the river-right to the river-left side. Because of this shift, the large left-hand curve in the river is straightening, and shows some reversal in post-dam construction aerial photos. This reversal has caused the downstream left-hand bend to become more abrupt, and most likely has accelerated the erosion on the downstream right-bank.

Notes on accuracy of image correlation: No adjustment to the images was necessary. Approximate image accuracy (compared with 1998 DOQQ images) is listed below. Distances are approximate and indicate the length and direction the indicated photomosaic varies from the 1998 DOQQ:

YEAR	DISTANCE	DIRECTION
1909	17 m	NW
1956 / 1962	10 m	NW
1967	3 m	W
1986	10 m	W

FERC SP-G2: Erosion Site Description and Analysis Summary

Site Name: RM 46.4

Site location: Between RM 46.7 and 45.7 along the river-left bank on a right-handed bend.

Erosion Calculation Summary:

Pre-Dam Construction:

Maximum erosion width: 637 ft

Average erosion rate: 11 ft/yr

Post-Dam Construction:

Maximum erosion width: 619 ft

Average erosion rate: 19 ft/yr

Description: This site displays a non-uniform rate of erosion due to the influence of a levee constructed between the 1909 and 1956 study years and subsequent failure and progressive erosion of the levee between the 1956 and 1986 study years. As originally constructed, the levee was continuous along the river-left side of the entire erosion study reach. Erosion of the levee appears to begin between RM 46.1 and 46.5 in the 1967 study year and continues downstream in subsequent years. The resulting pattern of erosion shows maximum pre-dam erosion rates within the upstream half of the site while maximum post-dam erosion occurs within the lower half of the site. Also, there is evidence of earth-fill construction along the cut bank between RM 45.9 and the downstream end of the erosion site between the 1986 and 1998 study years.

Notes on accuracy of image correlation: No adjustment to the images was necessary. Approximate image accuracy (compared with 1998 DOQQ images) is listed below. Distances are approximate and indicate the length and direction the indicated photomosaic varies from the 1998 DOQQ:

YEAR	DISTANCE	DIRECTION
1909	17 m	NW
1956 / 1962	10 m	NW
1967	3 m	W
1986	10 m	W

FERC SP-G2: Erosion Site Description and Analysis Summary

Site Name: RM 52.3

Site location: Between RM 52.4 and 51.6 along the river-right bank on a right-handed bend.

Erosion Calculation Summary:

Pre-Dam Construction:

Maximum erosion width: 567 ft

Average erosion rate: 10 ft/yr

Post-Dam Construction:

Maximum erosion width: 514 ft

Average erosion rate: 16 ft/yr

Description: Erosion at this site occurs predominantly along the upstream portion of a point bar. A considerable amount of erosion occurred between 1909 and 1956 and between 1967 and 1986. Some aggradation occurred between 1986 and 1998, although this was most likely due to earth-fill construction activity along the eroded bank (see 1986 air photo).

Notes on accuracy of image correlation: No adjustment to the images was necessary. Approximate image accuracy (compared with 1998 DOQQ images) is listed below. Distances are approximate and indicate the length and direction the indicated photomosaic varies from the 1998 DOQQ:

YEAR	DISTANCE	DIRECTION
1909	20 m (?)	SE
1956 / 1962	7 m	E
1967	5 m	E
1986	10 m	E

FERC SP-G2: Erosion Site Description and Analysis Summary

Site Name: Robinson Riffle

Site location: Between RM 59.0 and RM 62.0.

Erosion Calculation Summary: Due to the nature of this site (described below), erosion calculations were not completed for the Robinson Riffle site.

Description: Historically, and continuing to the present day, the nature of this river reach has been heavily impacted by dredging operations. Dredging operations were ongoing as early as 1909 (pre-dam construction), as is evident in the 1909 survey image and visible on the latest 1998 aerial photo (post-dam construction). The early dredging operations were the result of gold mining in the region; dredging operations currently underway are a result of sand and gravel mining operations. Due to the strong influence of dredging operations and its resultant impact to the Feather River between RM 59.0 through RM 62.0, erosion calculations were not completed for this site. The 1909 survey and the aerial photos depicting the changing river system at the Robinson Riffle site for the years 1909, 1956, 1967, 1986 and 1998 are shown on Plates 1 through 5. An overview of the significant changes that have occurred at the site based on a review of the aerial photos is summarized below:

1909: RM 62.0 through RM 59.2 is characterized by multiple channels, separated by numerous dredge tailing sites. Tailing sites occur to the north, to the south and in between the various channels. The most extensive of these tailing sites (covering over 850 acres) occurs to the north of the northern-most channel, near RM 62.0. Only RM 59.0 to 59.2 is characterized by one main channel; this main channel course approximates that visible in the1998 photo. Extensive dredge tailings (covering over 500 acres) are similarly located south of this channel.

1956: RM 62.0 through RM 60.6 is characterized by multiple channels, as is the case in the 1909 photo; the channel locations vary slightly from the prior year. RM 59.0 to 60.5 is now characterized as having one main channel. The extensive dredge tailings visible in the 1909 photo remain visible throughout the site, with additional tailings now visible to the north of the channel, at RM 60.0 to RM 59.0.

1967: The extensive dredge tailings visible in the 1956 photo remain visible throughout the site. RM 62.0 to 60.0 appears to contain one predominant channel, unlike in prior photo years (1909 and 1956). Additionally, sand bars are now visible in the

Site Name: Robinson Riffle (Continued)

main (and only) channel near RM 60.0 to RM 59.3, where none were visible in prior years.

1986: The site appears similar in character to that of the prior photo year (1967). Extensive dredge tailing piles and pits remain visible throughout the site. A notable change, absent from the prior year photo (1967), is the presence of a water-filled depression, located to the south of the channel at RM 61.0. The water-filled depression/sediment loss appears to be the result of human activity.

1998: The character of the site does not vary significantly from the prior photo year (1986).

FERC SP-G2 TASK 5B
EROSION SITE ANALYSIS

For selected sites along the upper reach of the Feather River (Oroville Dam to Yuba City / Marysville)

Erosion Site Analysis at Site 28.6

General Site Description

Located along river-left bank on a right-handed bend

Upstream Extent (river mile)	28.76
Downstream Extent (river mile)	28.24
Length of Erosion Site (river miles)	0.52

Measurements and Calculations

Date	# of months spanned	Cut Bank Length (m)	Cut Bank Length (ft)	Avg. Cut Bank Length (ft)	Area between cut banks (m^2)	Area between cut banks (ft^2)	Area between cut banks (acres)	Eroded area per avg. cut bank length (acres/ft)	Erosion rate for avg. cut bank (acres/ft/month)	Erosion rate for avg. cut bank (acres/ft/year)	Max. width of erosion (m)	Max. width of erosion (ft)	Rate of Max. erosion (ft/year)	Direction of max. erosion (North Azimuth)
Sep-09		927.72	3,043.7											
	560			3,044.9	97,060.3	1,044,368.9	78.69	0.026	0.00005	0.00055		pre-dam		pre-dam
May-56		928.47	3,046.1											
	139			2,872.1	0	0.0	0.00	0.000	0.00000	0.00000	215.0	705.3	12.1	119
Dec-67		822.35	2,698.0											
	229			2,702.6	16,304.8	175,439.3	13.22	0.005	0.00002	0.00026		post-dam		post-dam
Jan-86		825.19	2,707.3											
	152			2,682.6	26,301.8	283,007.0	21.32	0.008	0.00005	0.00063	110.8	363.5	11.4	123
Sep-98		810.12	2,657.8											

Estimated "cut" and "fill" (m^2)

1909 to 1956		1956 to 1967		1967 to 1986		1986 to 1998	
cut	fill	cut	fill	cut	fill	cut	fill
97,060.3	0	0	38,011.0	16,304.8	12.27	26,301.8	0

FERC SP-G2 TASK 5B
EROSION SITE ANALYSIS
For selected sites along the upper reach of the Feather River
(Oroville Dam to Yuba City / Marysville)

Erosion Site Analysis at Site 33.5

General Site Description

Located along river-right bank on a left-handed bend

Upstream Extent (river mile)	33.65
Downstream Extent (river mile)	33.41
Length of Erosion Site (river miles)	0.24

Measurements and Calculations

Date	# of months spanned	Cut Bank Length (m)	Cut Bank Length (ft)	Avg. Cut Bank Length (ft)	Area between cut banks (m^2)	Area between cut banks (ft^2)	Area between cut banks (acres)	Eroded area per avg. cut bank length (acres/ft)	Erosion rate for avg. cut bank (acres/ft/month)	Erosion rate for avg. cut bank (acres/ft/year)	Max. width of erosion (m)	Max. width of erosion (ft)	Rate of Max. erosion (ft/year)	Direction of max. erosion (North Azimuth)
Sep-09		441.09	1,447.1											
	560			1,623.4	19,084.3	205,347.0	15.47	0.010	0.00002	0.00020		pre-dam		pre-dam
May-56		548.57	1,799.7											
	139			1,693.1	9,909.69	106,628.2	8.03	0.005	0.00003	0.00041	68.5	224.7	3.9	346
Dec-67		483.57	1,586.5											
	229			1,611.7	5,845.8	62,900.5	4.74	0.003	0.00001	0.00015		post-dam		post-dam
Jan-86		498.93	1,636.9											
	152			1,637.0	746.3	8,029.8	0.60	0.000	0.00000	0.00003	29.6	97.0	3.1	293
Sep-98		498.99	1,637.1											

Estimated "cut" and "fill" (m^2)

1909 to 1956		1956 to 1967		1967 to 1986		1986 to 1998	
cut	fill	cut	fill	cut	fill	cut	fill
17.9		9,909.69	14,261.6	5,845.8	4,786.15		154.0
19,066.38							60.77
	1,900.65					24.24	
						31.01	
						691.02	

FERC SP-G2 TASK 5B
EROSION SITE ANALYSIS
For selected sites along the upper reach of the Feather River
(Oroville Dam to Yuba City / Marysville)

Erosion Site Analysis at Site 34.0

General Site Description

Located along left-bank on a right-handed bend

	Pre-dam	Post-dam
Upstream Extent (river mile)	34.53	34.47
Downstream Extent (river mile)	33.62	33.50
Length of Erosion Site (river miles)	0.91	0.97

Measurements and Calculations

Date	# of months spanned	Cut Bank Length (pre-dam) (m)	Cut Bank Length (pre-dam) (ft)	Avg. Cut Bank Length (pre-dam) (ft)	Cut Bank Length (post-dam) (m)	Cut Bank Length (post-dam) (ft)	Avg. Cut Bank Length (ft)	Area between cut banks (m2)	Area between cut banks (ft^2)	Area between cut banks (acres)	Eroded area per avg. cut bank length (acres/ft)	Erosion rate for avg. cut bank (acres/ft/year)	Max. width of erosion (m)	Max. width of erosion (ft)	Rate of Max. erosion (ft/year)	Direction of max. erosion (North Azimuth)
Sep-09		687.53	2,255.65													
	560			2,655.61				61,883.1	665,862.1	50.17	0.019	0.00040		pre-dam		pre-dam
May-56		931.35	3,055.57													
	139			2,961.83				21,799.1	234,558.2	17.67	0.006	0.00052	147.0	482.2	8.3	350
Dec-67		874.21	2,868.10		975.33	3,199.86										
	229						3,695.3	112,739.22	1,213,074.0	91.40	0.025	0.00130		post-dam		post-dam
Jan-86					1,277.33	4,190.67										
	152						4,301.6	13,001.5	139,895.7	10.54	0.002	0.00019	226.5	743.1	23.4	326
Sep-98					1,344.94	4,412.46										

Estimated "cut" and "fill" (m^2)

1909 to 1956		1956 to 1967		1967 to 1986		1986 to 1998	
cut	fill	cut	fill	cut	fill	cut	fill
61,770.5	1,109.11	6,622.29	290.55	112,739.22	0	13,001.5	703.3
112.58		881.42	839.24				12.04
		173.95					
		14,121.43					

FERC SP-G2 TASK 5B
EROSION SITE ANALYSIS
For selected sites along the upper reach of the Feather River
(Oroville Dam to Yuba City / Marysville)

Erosion Site Analysis at Site 34.5

General Site Description

Located along right-bank on a left-handed bend

	Pre-dam	Post-dam
Upstream Extent (river mile)	34.90	34.78
Downstream Extent (river mile)	34.38	34.25
Length of Erosion Site (river miles)	0.52	0.53

Measurements and Calculations

Date	# of months spanned	Cut Bank Length (pre-dam) (m)	Cut Bank Length (pre-dam) (ft)	Avg. Cut Bank Length (pre-dam) (ft)	Cut Bank Length (post-dam) (m)	Cut Bank Length (post-dam) (ft)	Avg. Cut Bank Length (ft)	Area between cut banks (m^2)	Area between cut banks (ft^2)	Area between cut banks (acres)	Eroded area per avg. cut bank length (acres/ft)	Erosion rate for avg. cut bank (acres/ft/year)	Max. width of erosion (m)	Max. width of erosion (ft)	Rate of Max. erosion (ft/year)	Direction of max. erosion (North Azimuth)
Sep-09		605.40	1,986.18													
	560			2,826.32				89,087.8	958,585.2	72.22	0.026	0.00055		pre-dam		pre-dam
May-56		1,117.55	3,666.46													
	139			3,479.09				74,678.7	803,543.3	60.54	0.017	0.00150	310.9	1,019.9	17.5	270
Dec-67		1,003.33	3,291.73		660.02	2,165.40										
	229						2,559.0	92,068.78	990,660.0	74.64	0.029	0.00153		post-dam		post-dam
Jan-86					899.98	2,952.65										
	152						2,922.1	12,504.8	134,551.4	10.14	0.003	0.00027	207.9	682.1	21.5	8
Sep-98					881.35	2,891.53										

Estimated "cut" and "fill" (m^2)

1909 to 1956		1956 to 1967		1967 to 1986		1986 to 1998	
cut	fill	cut	fill	cut	fill	cut	fill
89,087.8	0	74,184.97 493.77	26,277.88	92,068.78	0	12,504.8	1,124.0

FERC SP-G2 TASK 5B
EROSION SITE ANALYSIS
For selected sites along the upper reach of the Feather River
(Oroville Dam to Yuba City / Marysville)

Erosion Site Analysis at Site 35.0

General Site Description

Located along left-bank on a right-handed bend

	Pre-dam	Post-dam
Upstream Extent (river mile)	35.39	35.45
Downstream Extent (river mile)	34.91	34.79
Length of Erosion Site (river miles)	0.48	0.66

Measurements and Calculations

Date	# of months spanned	Cut Bank Length (pre-dam) (m)	Cut Bank Length (pre-dam) (ft)	Avg. Cut Bank Length (pre-dam) (ft)	Cut Bank Length (post-dam) (m)	Cut Bank Length (post-dam) (ft)	Avg. Cut Bank Length (ft)	Area between cut banks (m^2)	Area between cut banks (ft^2)	Area between cut banks (acres)	Eroded area per avg. cut bank length (acres/ft)	Erosion rate for avg. cut bank (acres/ft/year)	Max. width of erosion (m)	Max. width of erosion (ft)	Rate of Max. erosion (ft/year)	Direction of max. erosion (North Azimuth)
Sep-09		844.63	2,771.06													
	560			3,301.09				112,036.9	1,205,517.0	90.83	0.028	0.00059		pre-dam		pre-dam
May-56		1,167.74	3,831.13													
	139			3,475.34				30,851.2	331,959.2	25.01	0.007	0.00062	331.5	1,087.6	18.7	309
Dec-67		950.85	3,119.55		1,214.76	3,985.37										
	229						4,011.8	48,434.90	521,159.5	39.27	0.010	0.00051		post-dam		post-dam
Jan-86					1,230.84	4,038.14										
	152						4,060.5	7,771.8	83,624.9	6.30	0.002	0.00012	84.6	277.6	8.7	340
Sep-98					1,244.48	4,082.87										

Estimated "cut" and "fill" (m^2)

1909 to 1956		1956 to 1967		1967 to 1986		1986 to 1998	
cut	fill	cut	fill	cut	fill	cut	fill
112,036.9	9,300.87	30,426.85	982.22	13,062.70	167.36	7,694.4	122.2
		424.38	1,759.80	35,372.20		41.10	63.33
						9.54	41.94
						26.78	110.98

FERC SP-G2 TASK 5B
EROSION SITE ANALYSIS
For selected sites along the upper reach of the Feather River
(Oroville Dam to Yuba City / Marysville)

Erosion Site Analysis at Site 44.0

General Site Description

Located along left-bank on a right-handed bend

Upstream Extent (river mile)	44.35
Downstream Extent (river mile)	43.64
Length of Erosion Site (river miles)	0.71

Measurements and Calculations

Date	# of months spanned	Cut Bank Length (m)	Cut Bank Length (ft)	Avg. Cut Bank Length (ft)	Area between cut banks (m^2)	Area between cut banks (ft^2)	Area between cut banks (acres)	Eroded area per avg. cut bank length (acres/ft)	Erosion rate for avg. cut bank (acres/ft/month)	Erosion rate for avg. cut bank (acres/ft/year)	Max. width of erosion (m)	Max. width of erosion (ft)	Rate of Max. erosion (ft/year)	Direction of max. erosion (North Azimuth)
Sep-09		1,095.54	3,594.2											
	560			3,681.5	96,849.5	1,042,100.1	78.52	0.021	0.00004	0.00046		pre-dam		pre-dam
May-56		1,148.74	3,768.8											
	139			3,846.9	15,774.7	169,735.8	12.79	0.003	0.00002	0.00029	162.4	532.8	9.1	126
Dec-67		1,196.33	3,924.9											
	229			4,093.5	80,296.8	863,993.5	65.10	0.016	0.00007	0.00083		post-dam		post-dam
Jan-86		1,299.10	4,262.1											
	152			4,146.9	19,233.3	206,949.8	15.59	0.004	0.00002	0.00030	162.3	532.5	16.8	338
Sep-98		1,228.87	4,031.7											

Estimated "cut" and "fill" (m^2)

1909 to 1956		1956 to 1967		1967 to 1986		1986 to 1998	
cut	fill	cut	fill	cut	fill	cut	fill
96,849.5	867.31	15,744.11	2,421.4	72.5	259.21	187.7	121.35
		30.60	1,572.44	80,145.31	21.73	19045.54	
			312.64	79.00	81.49		
					61.12		

FERC SP-G2 TASK 5B
EROSION SITE ANALYSIS
For selected sites along the upper reach of the Feather River
(Oroville Dam to Yuba City / Marysville)

Erosion Site Analysis at Site 44.4

General Site Description

Located along river-right bank on a right-handed bend

Upstream Extent (river mile)	44.60
Downstream Extent (river mile)	44.30
Length of Erosion Site (river miles)	0.30

Measurements and Calculations

Date	# of months spanned	Cut Bank Length (m)	Cut Bank Length (ft)	Avg. Cut Bank Length (ft)	Area between cut banks (m^2)	Area between cut banks (ft^2)	Area between cut banks (acres)	Eroded area per avg. cut bank length (acres/ft)	Erosion rate for avg. cut bank (acres/ft/month)	Erosion rate for avg. cut bank (acres/ft/year)	Max. width of erosion (m)	Max. width of erosion (ft)	Rate of Max. erosion (ft/year)	Direction of max. erosion (North Azimuth)
Sep-09		598.98	1,965.1											
	560			1,825.7	25,373.8	273,022.0	20.57	0.011	0.00002	0.00024		pre-dam		pre-dam
May-56		514.00	1,686.3											
	139			1,681.7	2,685.3	28,893.5	2.18	0.001	0.00001	0.00011	97.5	319.8	5.5	217
Dec-67		511.15	1,677.0											
	229			1,655.9	17,025.0	183,189.2	13.80	0.008	0.00004	0.00044		post-dam		post-dam
Jan-86		498.27	1,634.7											
	152			1,688.1	19,378.8	208,516.2	15.71	0.009	0.00006	0.00073	104.8	343.9	10.8	37
Sep-98		530.83	1,741.6											

Estimated "cut" and "fill" (m^2)

1909 to 1956		1956 to 1967		1967 to 1986		1986 to 1998	
cut	fill	cut	fill	cut	fill	cut	fill
25,373.8	71.77	823.98	772.5	17,025.0	2,337.82	19,378.8	196.93
	8,323.98	10.51	614.81				
		86.34	17.60				
		72.92					
		1,691.52					

FERC SP-G2 TASK 5B
EROSION SITE ANALYSIS
For selected sites along the upper reach of the Feather River
(Oroville Dam to Yuba City / Marysville)

Erosion Site Analysis at Site 45.(

General Site Description

Located along river-left bank on a straight section of river

Upstream Extent (river mile)	45.42
Downstream Extent (river mile)	44.75
Length of Erosion Site (river miles)	0.67

Measurements and Calculations

Date	# of months spanned	Cut Bank Length (m)	Cut Bank Length (ft)	Avg. Cut Bank Length (ft)	Area between cut banks (m^2)	Area between cut banks (ft^2)	Area between cut banks (acres)	Eroded area per avg. cut bank length (acres/ft)	Erosion rate for avg. cut bank (acres/ft/month)	Erosion rate for avg. cut bank (acres/ft/year)	Max. width of erosion (m)	Max. width of erosion (ft)	Rate of Max. erosion (ft/year)	Direction of max. erosion (North Azimuth)
Sep-09		991.86	3,254.1											
	560			3,218.4	25,957.9	279,307.1	21.04	0.007	0.00001	0.00014		pre-dam		pre-dam
May-56		970.08	3,182.6											
	139			3,134.6	18,299.3	196,900.3	14.84	0.005	0.00003	0.00041	138.8	455.3	7.8	106.5
Dec-67		940.81	3,086.6											
	229			3,107.5	42,861.2	461,186.9	34.75	0.011	0.00005	0.00059		post-dam		post-dam
Jan-86		953.52	3,128.3											
	152			3,102.5	10,546.0	113,475.4	8.55	0.003	0.00002	0.00022	128.1	420.2	13.2	109.3
Sep-98		937.77	3,076.6											

Estimated "cut" and "fill" (m^2)

1909 to 1956		1956 to 1967		1967 to 1986		1986 to 1998	
cut	fill	cut	fill	cut	fill	cut	fill
25,087.89	1,776.85	18,299.29	218.32	237.63	31.23	10,370.64	912.60
870.02			18,417.74	42,623.61	22.88	175.40	

FERC SP-G2 TASK 5B
EROSION SITE ANALYSIS
For selected sites along the upper reach of the Feather River
(Oroville Dam to Yuba City / Marysville)

Erosion Site Analysis at Site 46.4

General Site Description

Located along river-left bank on a right-handed bend

Upstream Extent (river mile)	46.70
Downstream Extent (river mile)	45.67
Length of Erosion Site (river miles)	1.03

Measurements and Calculations

Date	# of months spanned	Cut Bank Length (m)	Cut Bank Length (ft)	Avg. Cut Bank Length (ft)	Area between cut banks (m^2)	Area between cut banks (ft^2)	Area between cut banks (acres)	Eroded area per avg. cut bank length (acres/ft)	Erosion rate for avg. cut bank (acres/ft/month)	Erosion rate for avg. cut bank (acres/ft/year)	Max. width of erosion (m)	Max. width of erosion (ft)	Rate of Max. erosion (ft/year)	Direction of max. erosion (North Azimuth)
Sep-09		1,495.16	4,905.3											
	560			4,906.1	107,210.4	1,153,584.4	86.92	0.018	0.00003	0.00038		pre-dam	pre-dam	pre-dam
May-56		1,495.61	4,906.8											
	139			5,091.6	63,309.5	681,210.7	51.33	0.010	0.00007	0.00087	194.1	636.9	10.9	124
Dec-67		1,608.25	5,276.4											
	229			5,313.3	70,088.2	754,148.7	56.82	0.011	0.00005	0.00056		post-dam	post-dam	post-dam
Jan-86		1,630.79	5,350.3											
	152			5,548.7	32,319.8	347,760.9	26.20	0.005	0.00003	0.00037	188.6	618.7	19.5	139
Sep-98		1,751.73	5,747.1											

Estimated "cut" and "fill" (m^2)

1909 to 1956		1956 to 1967		1967 to 1986		1986 to 1998	
cut	fill	cut	fill	cut	fill	cut	fill
107,210.4	0	63,309.5	0	70,088.2	0	32,319.8	14,095.6

FERC SP-G2 TASK 5B
EROSION SITE ANALYSIS
For selected sites along the upper reach of the Feather River
(Oroville Dam to Yuba City / Marysville)

Erosion Site Analysis at Site 52.3

General Site Description

Located along river-right bank on a right-handed bend

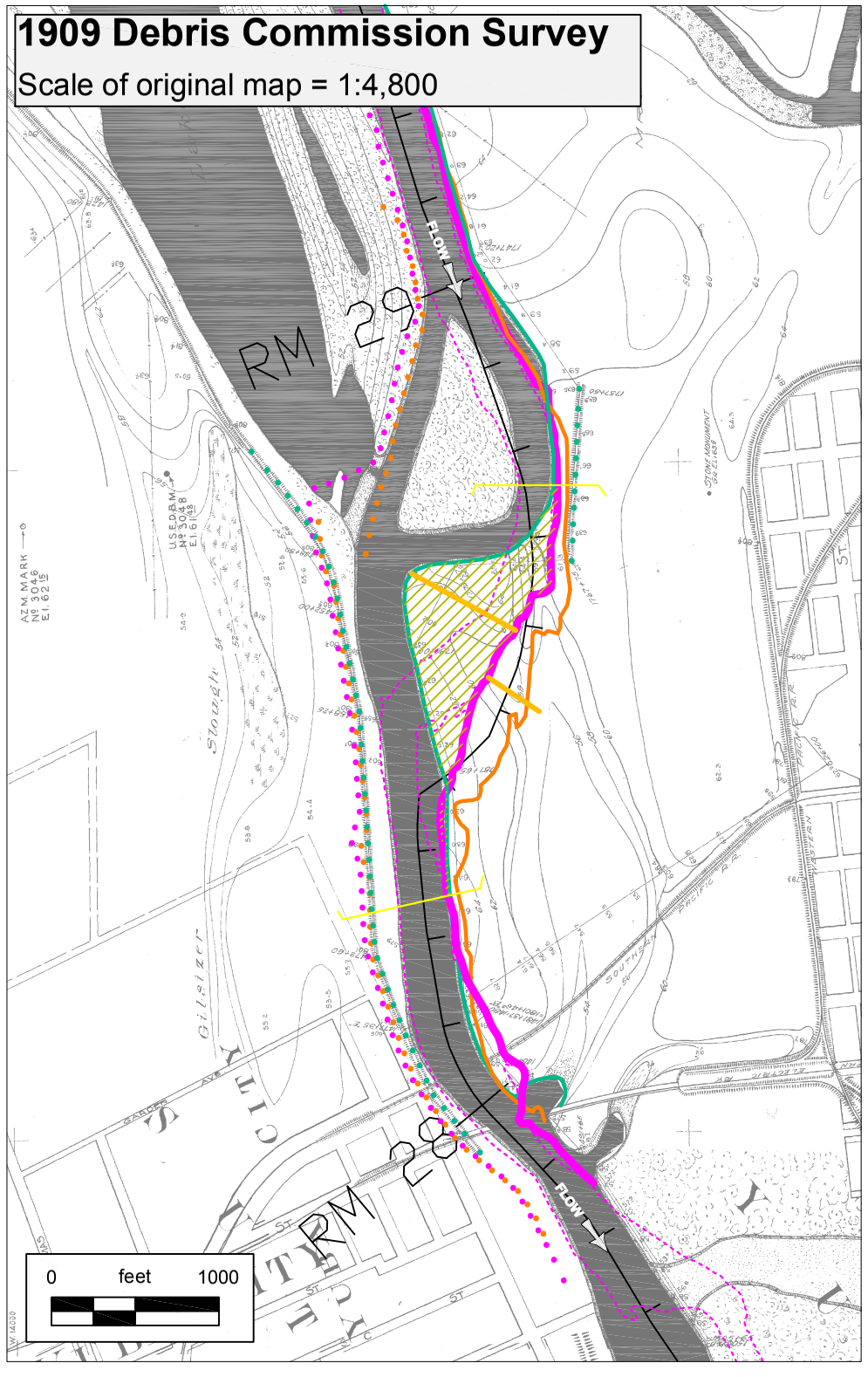
Upstream Extent (river mile)	52.43
Downstream Extent (river mile)	51.59
Length of Erosion Site (river miles)	0.84

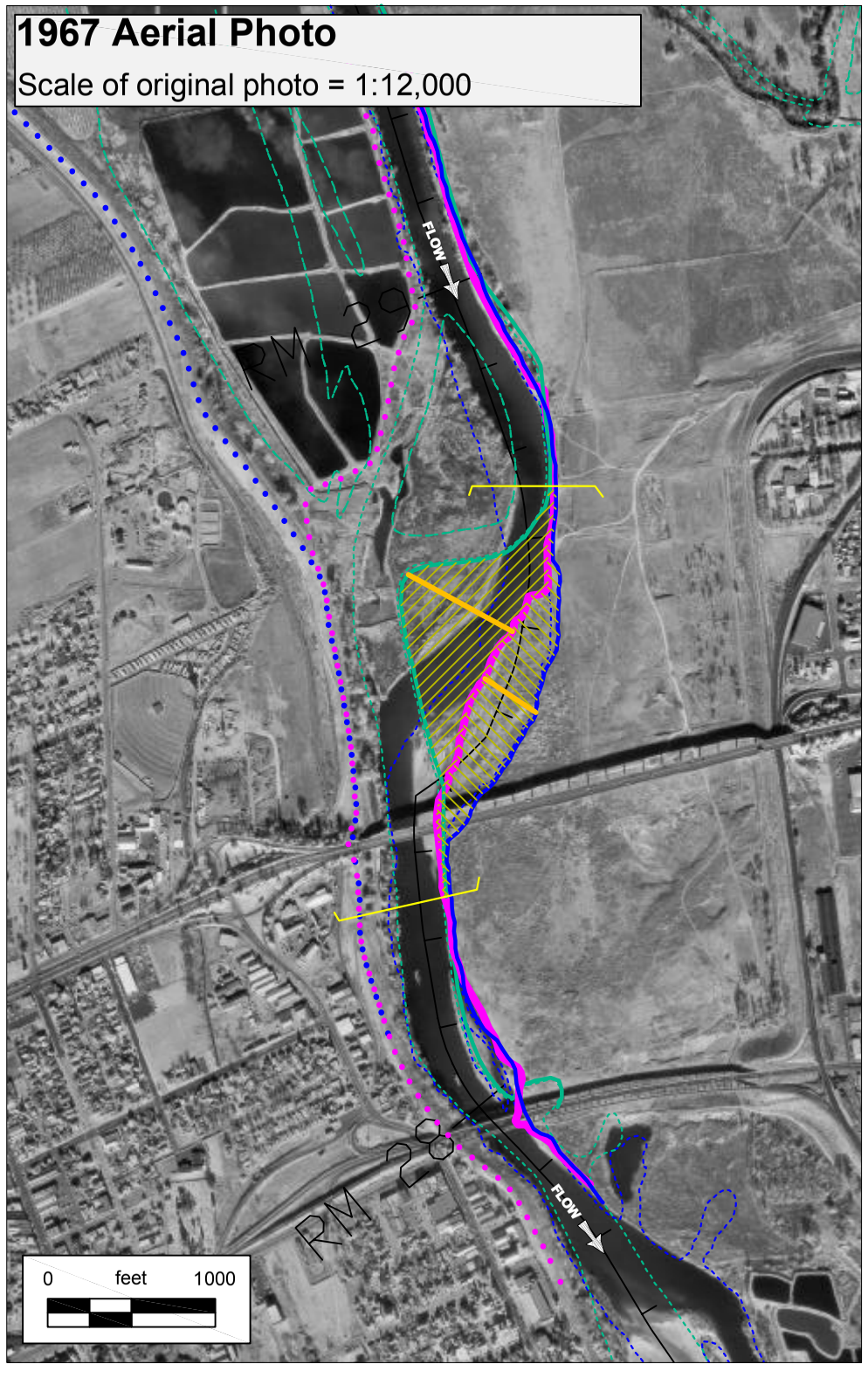
Measurements and Calculations

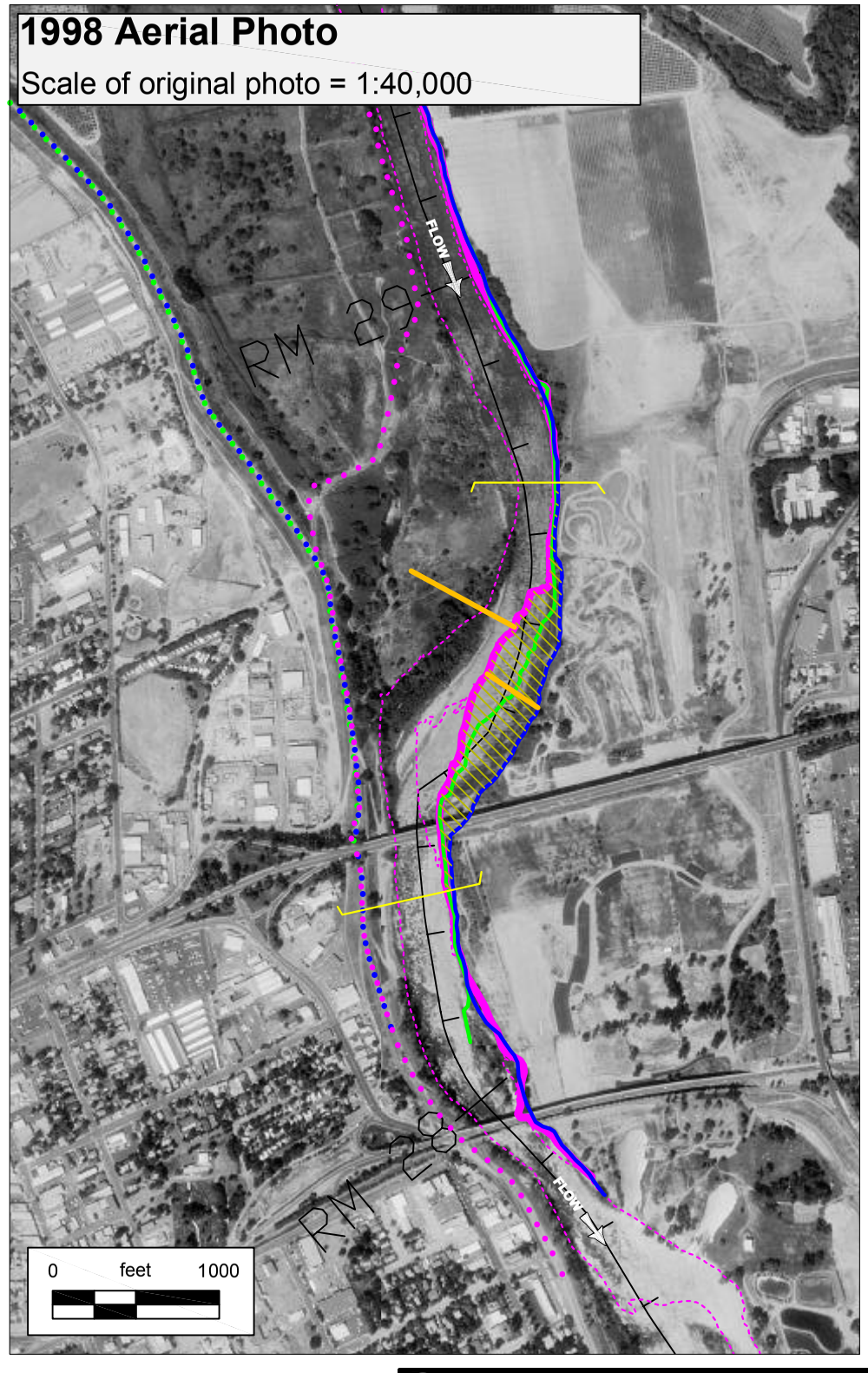
Date	# of months spanned	Cut Bank Length (m)	Cut Bank Length (ft)	Avg. Cut Bank Length (ft)	Area between cut banks (m^2)	Area between cut banks (ft^2)	Area between cut banks (acres)	Eroded area per avg. cut bank length (acres/ft)	Erosion rate for avg. cut bank (acres/ft/month)	Erosion rate for avg. cut bank (acres/ft/year)	Max. width of erosion (m)	Max. width of erosion (ft)	Rate of Max. erosion (ft/year)	Direction of max. erosion (North Azimuth)
Sep-09		1,067.40	3,501.9											
	560			3,196.2	46,050.5	495,503.4	37.33	0.012	0.00002	0.00025		pre-dam	pre-dam	pre-dam
May-56		881.03	2,890.5											
	139			2,851.3	1,951.2	20,994.4	1.58	0.001	0.00000	0.00005	172.8	566.8	9.7	253.7
Dec-67		857.14	2,812.1											
	229			2,822.3	58,545.1	629,945.7	47.46	0.017	0.00007	0.00088		post-dam	post-dam	post-dam
Jan-86		863.33	2,832.4											
	152			2,786.5	42.6	458.6	0.03	0.000	0.00000	0.00000	156.5	513.6	16.2	283.2
Sep-98		835.35	2,740.6											

Estimated "cut" and "fill" (m^2)

1909 to 1956		1956 to 1967		1967 to 1986		1986 to 1998	
cut	fill	cut	fill	cut	fill	cut	fill
45,120.7		222.3	167.6	58,490.6			11,364.1
	3,638.8	38.2	259.2		280.0	42.6	
929.8		60.9	15.4	54.5			
	9,011.2	12.1	1.3				
		1,617.7					







Water's Edge	Eroding Bank Edge	Levees
1909	1909	1909
1956	1956	1956
1967	1967	1967
1986	1986	1986
1998	1998	1998

- Erosion (pre-dam)
- Erosion (post-dam)
- Aggradation (pre-dam)
- Aggradation (post-dam)
- Maximum Erosion (pre- and post- dam)

STATE OF CALIFORNIA
DEPARTMENT OF WATER RESOURCES

Oroville Facilities Relicensing
FERC Project No. 2100

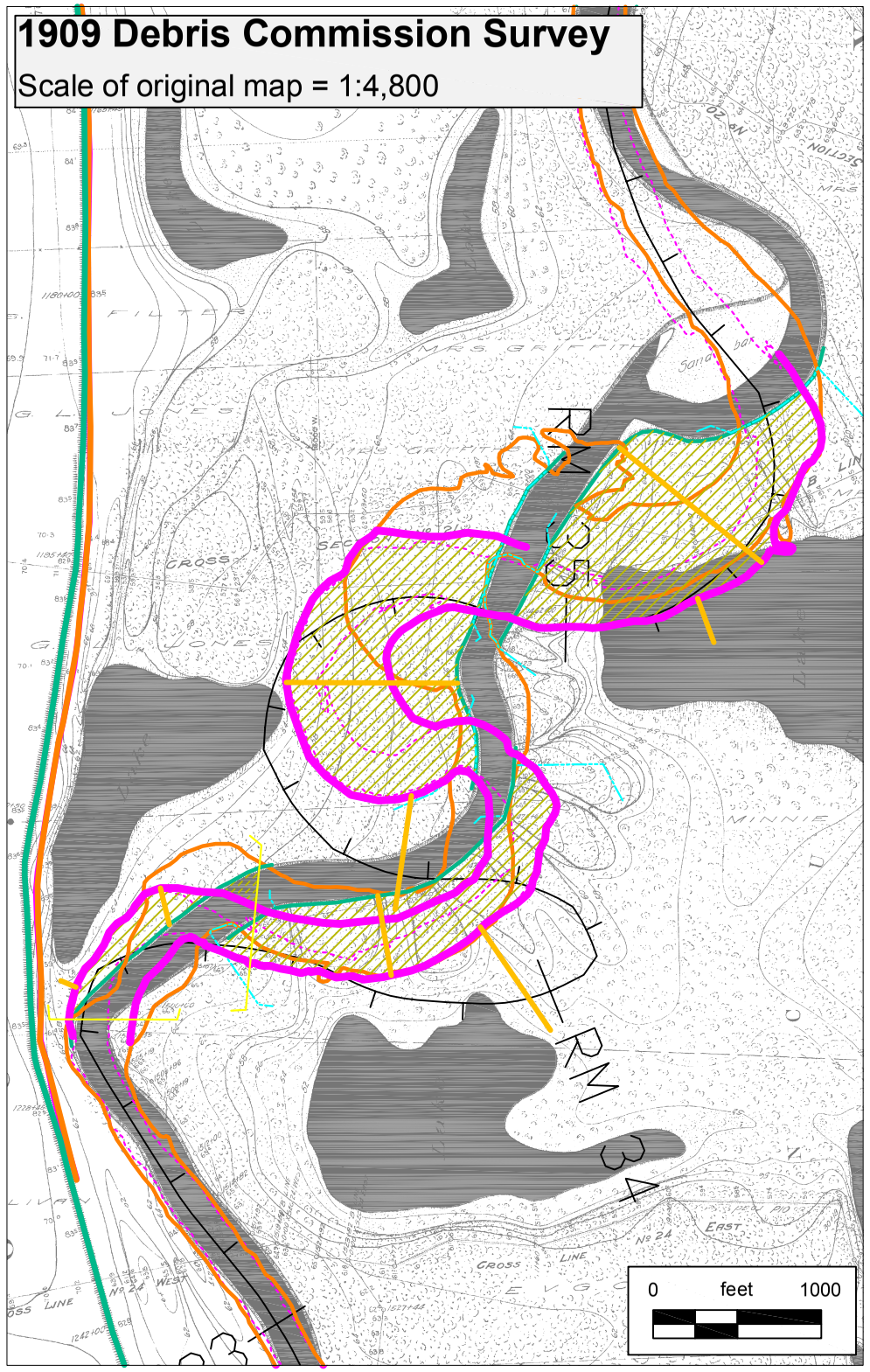
SP-G2 Task 5B
Bank Erosion Study

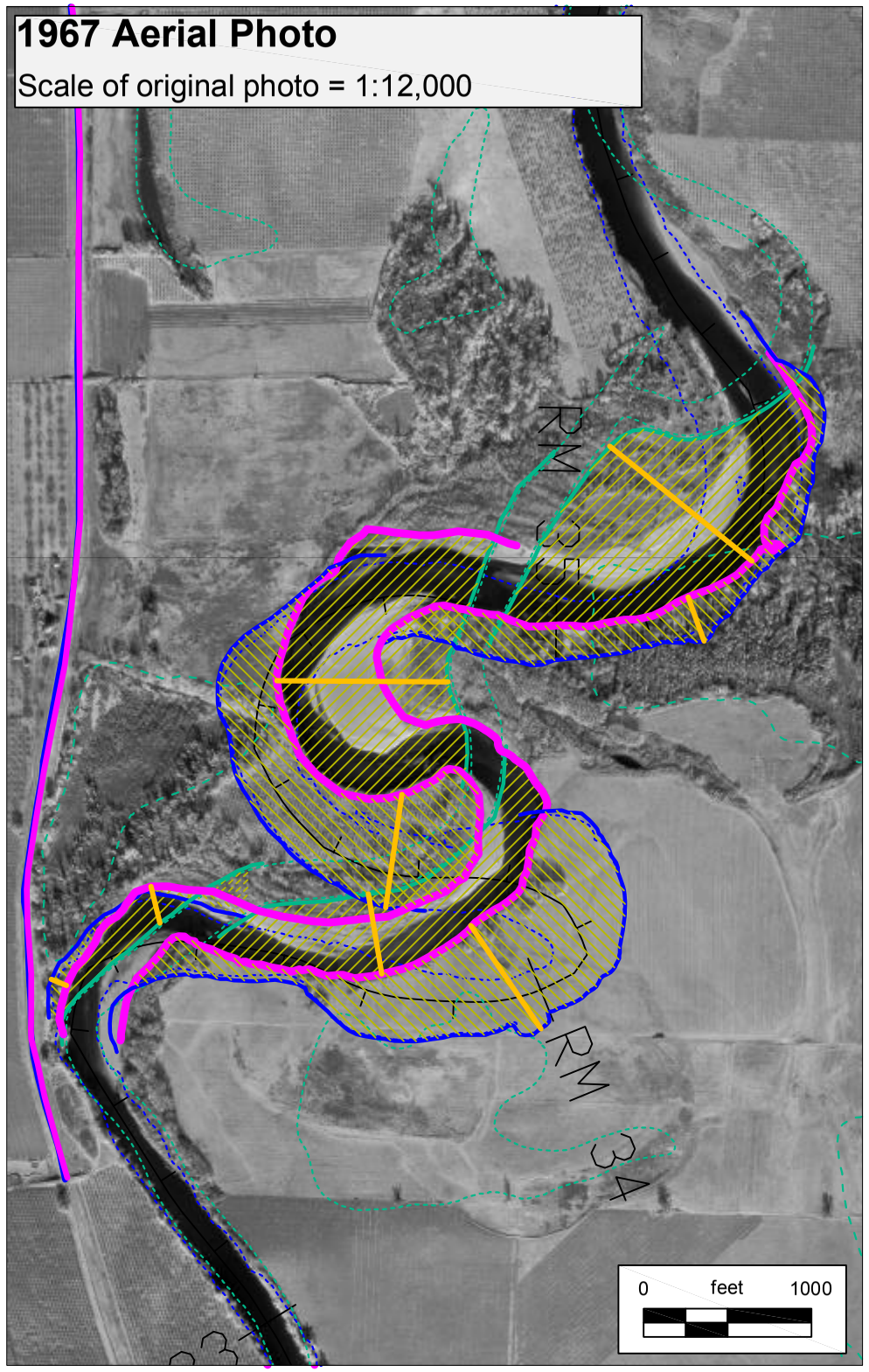
River Mile 28.6
River-Left Bank

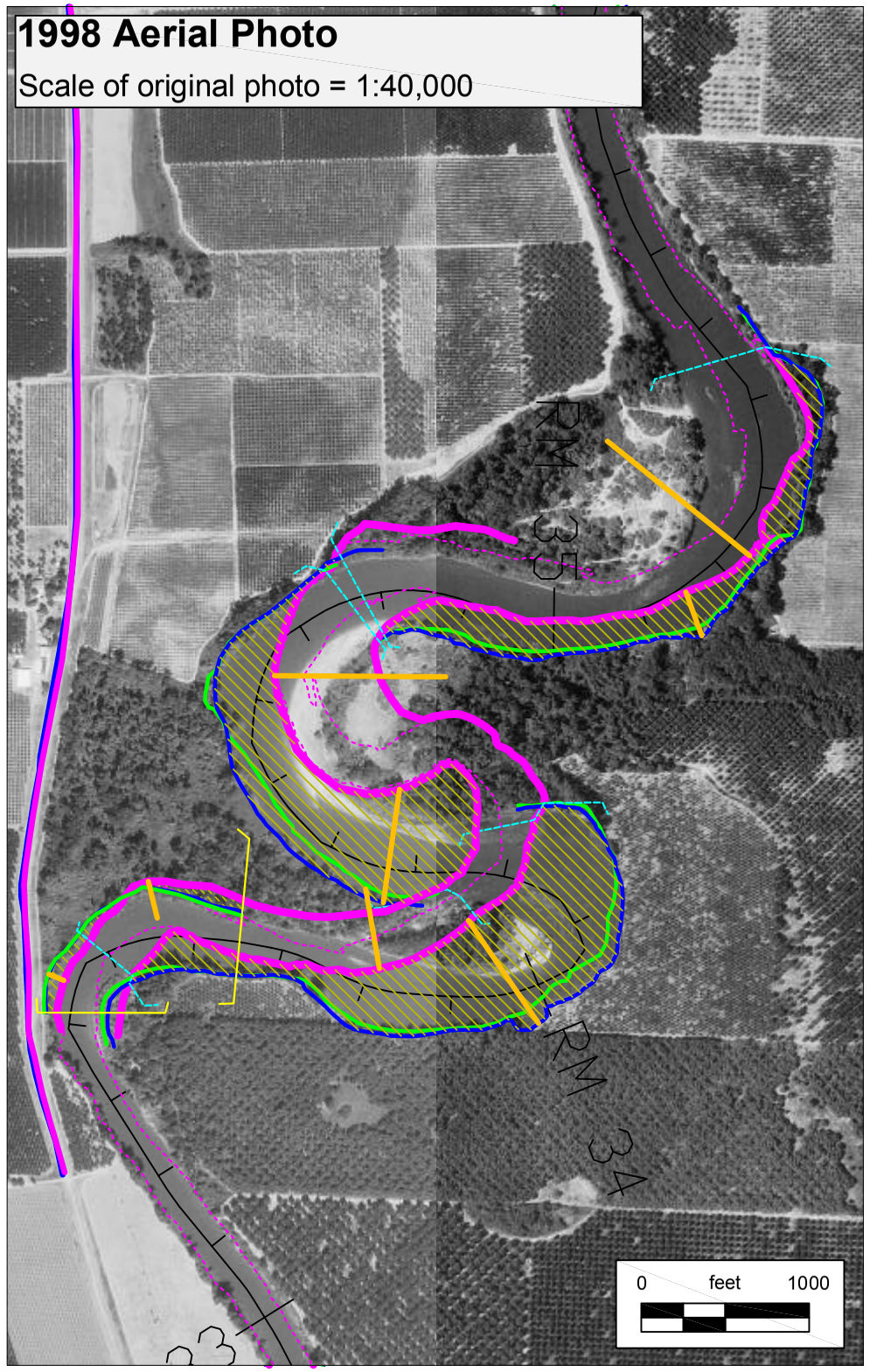
N

Prepared by: BB - DWR Central District
Date

RM_28.6, 12/5/2003 7:46:31 AM, Tabloid [11 x 17 in]







Analysis of linked bends

Rivermiles: 33.5 right bank
34 left bank*
34.5 right bank*
35 left bank*

***The pre-dam and post-dam erosion site boundaries are different for these sites.**

Water's Edge	Eroding Bank Edge	Levees
1909	1909	1909
1956	1956	1956
1967	1967	1967
1986	1986	1986
1998	1998	1998

- Erosion (pre-dam)
- Erosion (post-dam)
- Aggradation (pre-dam)
- Aggradation (post-dam)
- Maximum Erosion (pre- and post- dam)

STATE OF CALIFORNIA
DEPARTMENT OF WATER RESOURCES

Oroville Facilities Relicensing
FERC Project No. 2100

SP-G2 Task 5B

Bank Erosion Study

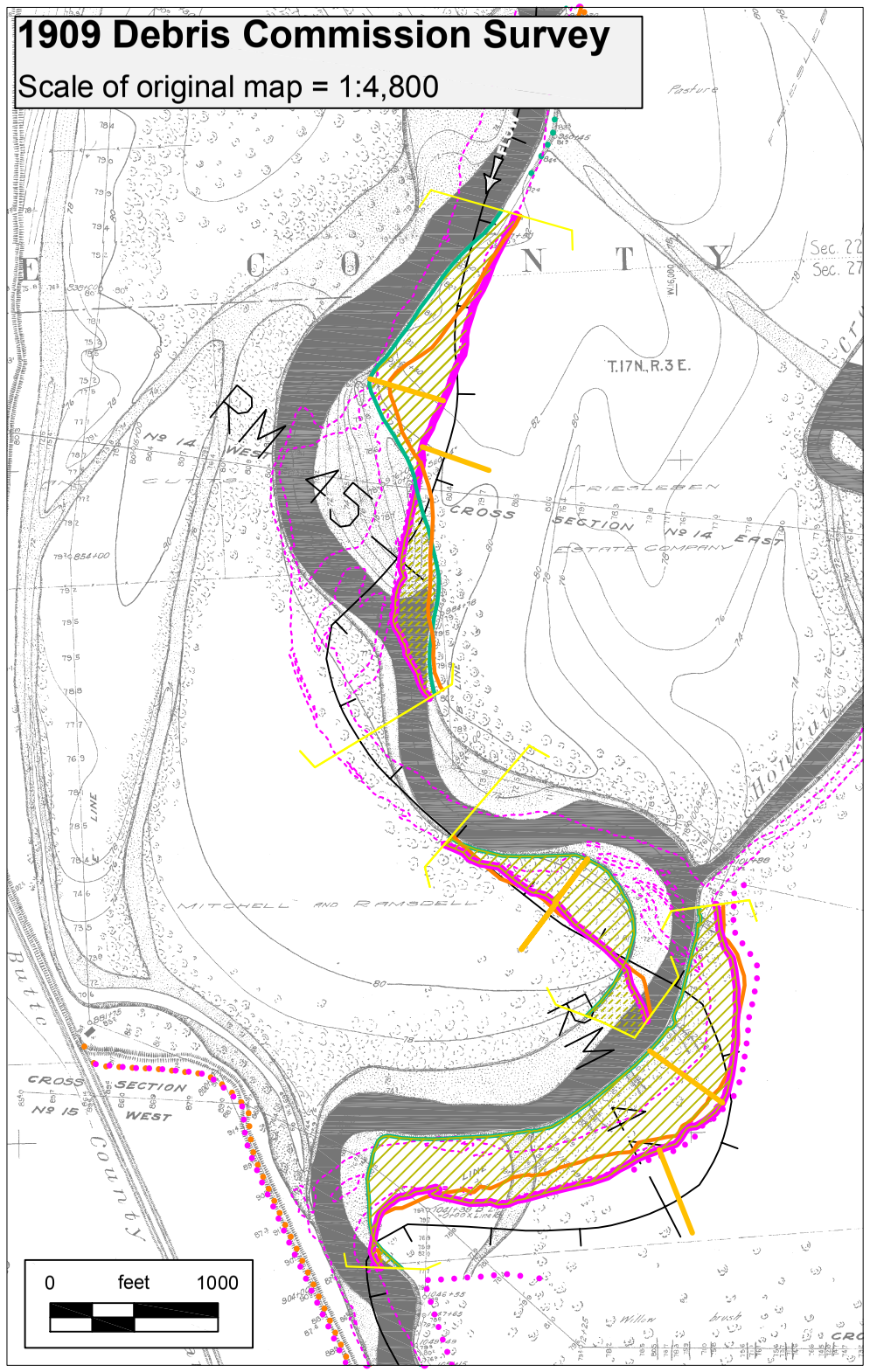
River Miles 33.5 to 35

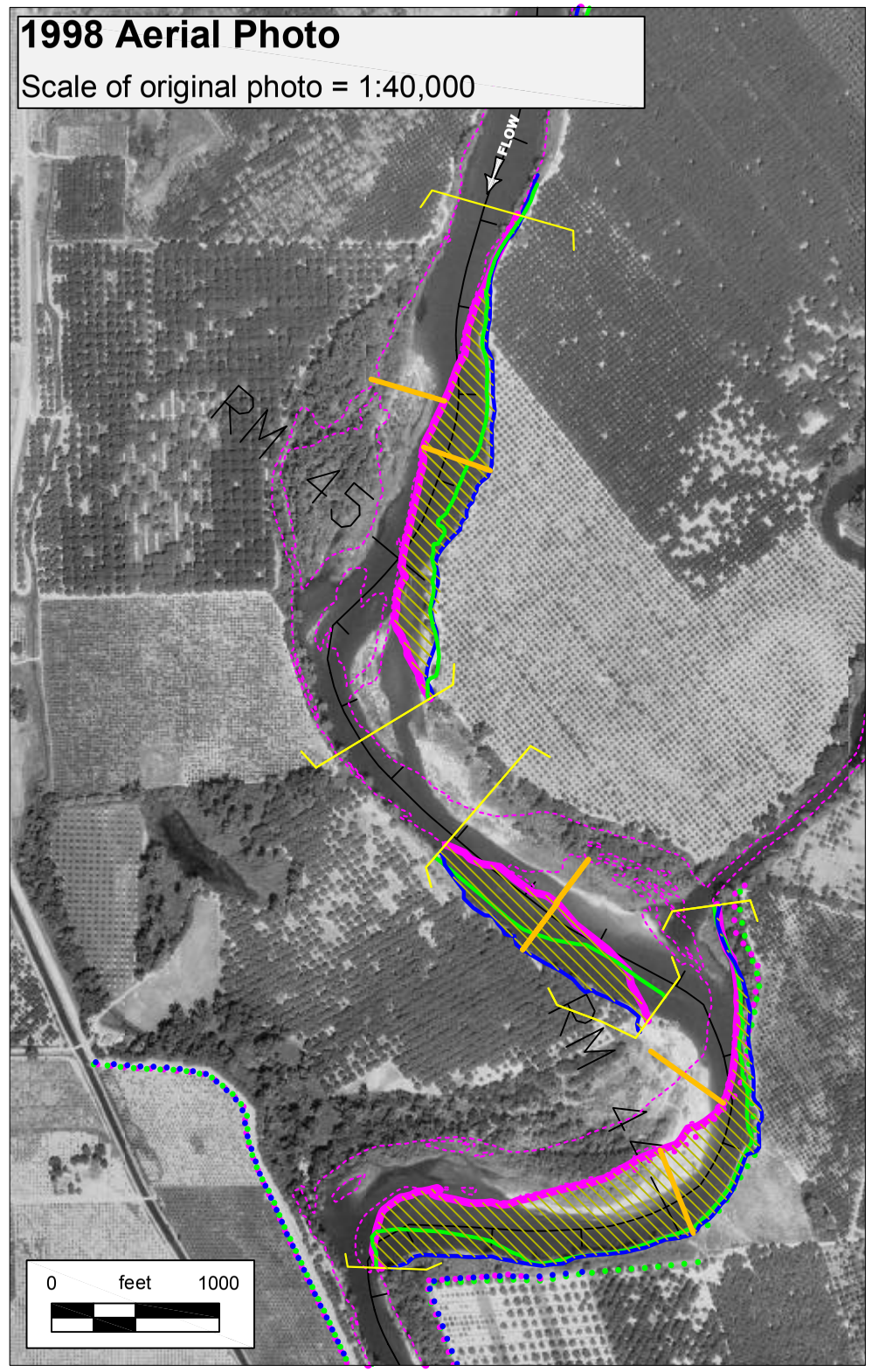
N

Prepared by: BB - DWR Central District

Date

RM_33.5, 12/17/2003 8:10:52 AM, Tabloid [11 x 17 in]





Analysis of linked bends

Rivermiles: **44 left bank**
44.4 right bank
45 left bank

Water's Edge	Eroding Bank Edge	Levees
1909	1909	1909
1956	1956	1956
1967	1967	1967
1986	1986	1986
1998	1998	1998

- Erosion (pre-dam)
- Erosion (post-dam)
- Aggradation (pre-dam)
- Aggradation (post-dam)
- Maximum Erosion (pre- and post- dam)

STATE OF CALIFORNIA
DEPARTMENT OF WATER RESOURCES

Oroville Facilities Relicensing
FERC Project No. 2100

SP-G2 Task 5B

Bank Erosion Study

River Mile 44 - 45

N

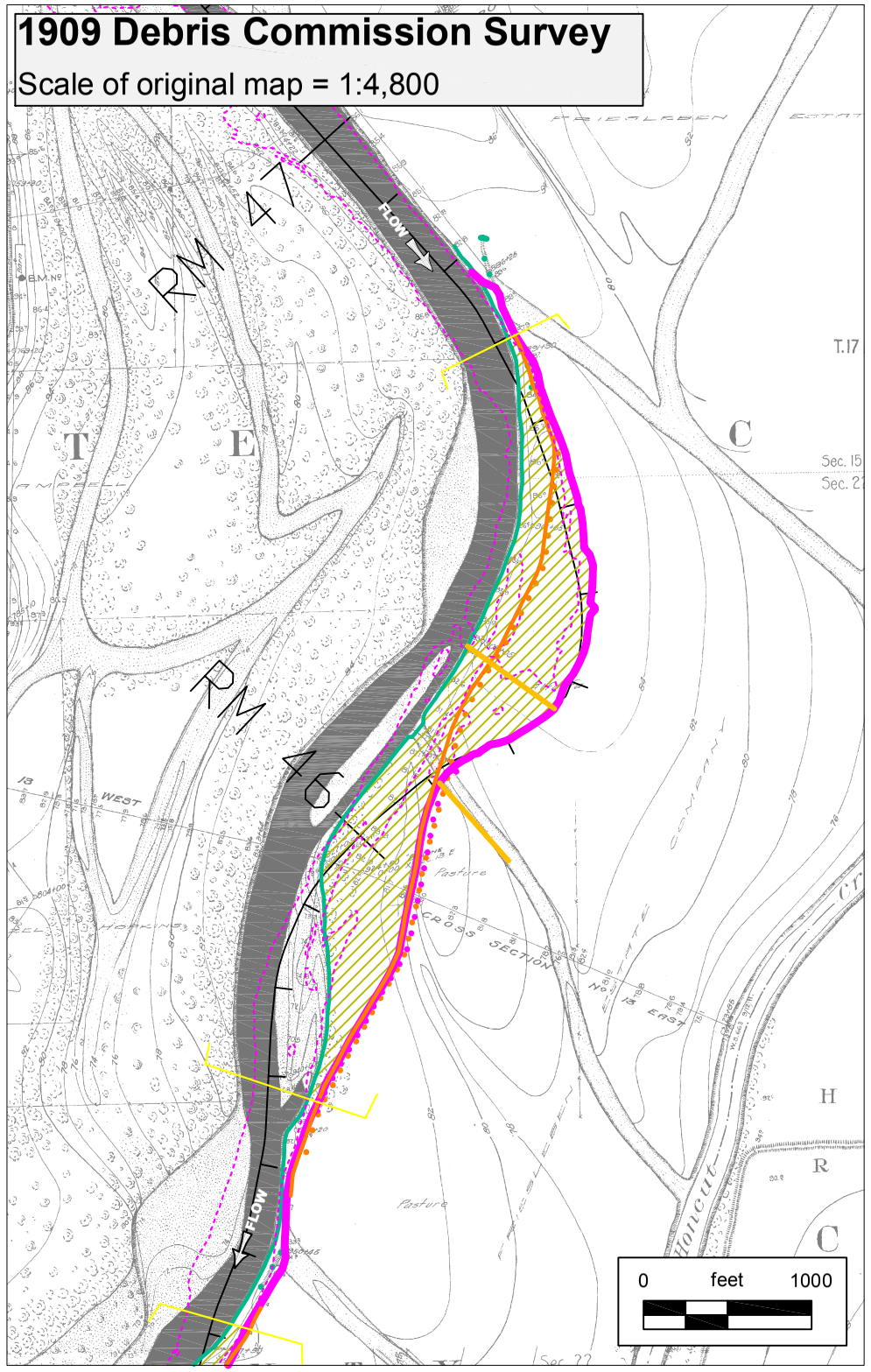
Prepared by: BB - DWR Central District

Date

RM_44-45, 12/17/2003 10:54:16 AM, Tabloid [11 x 17 in]

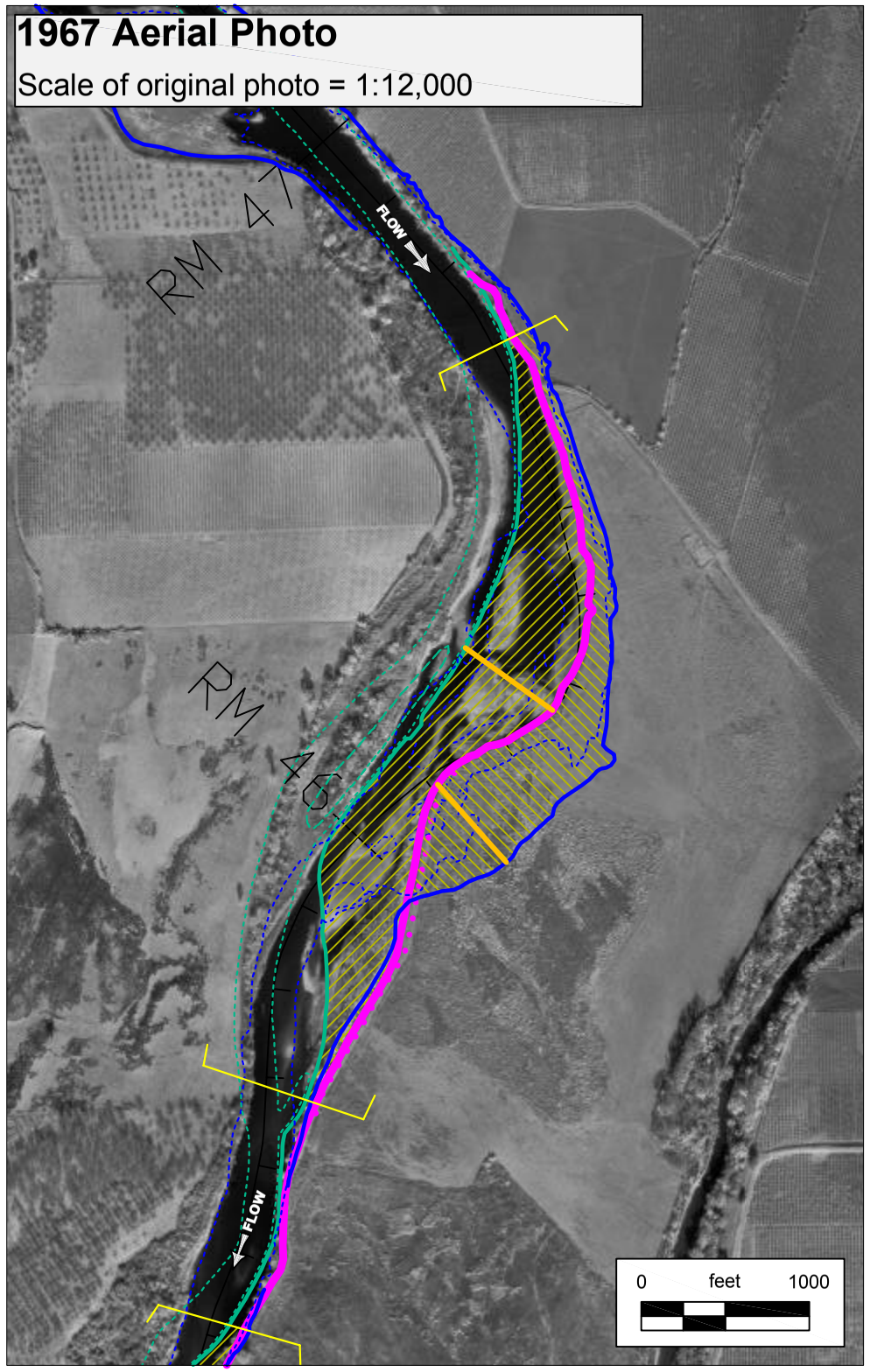
1909 Debris Commission Survey

Scale of original map = 1:4,800



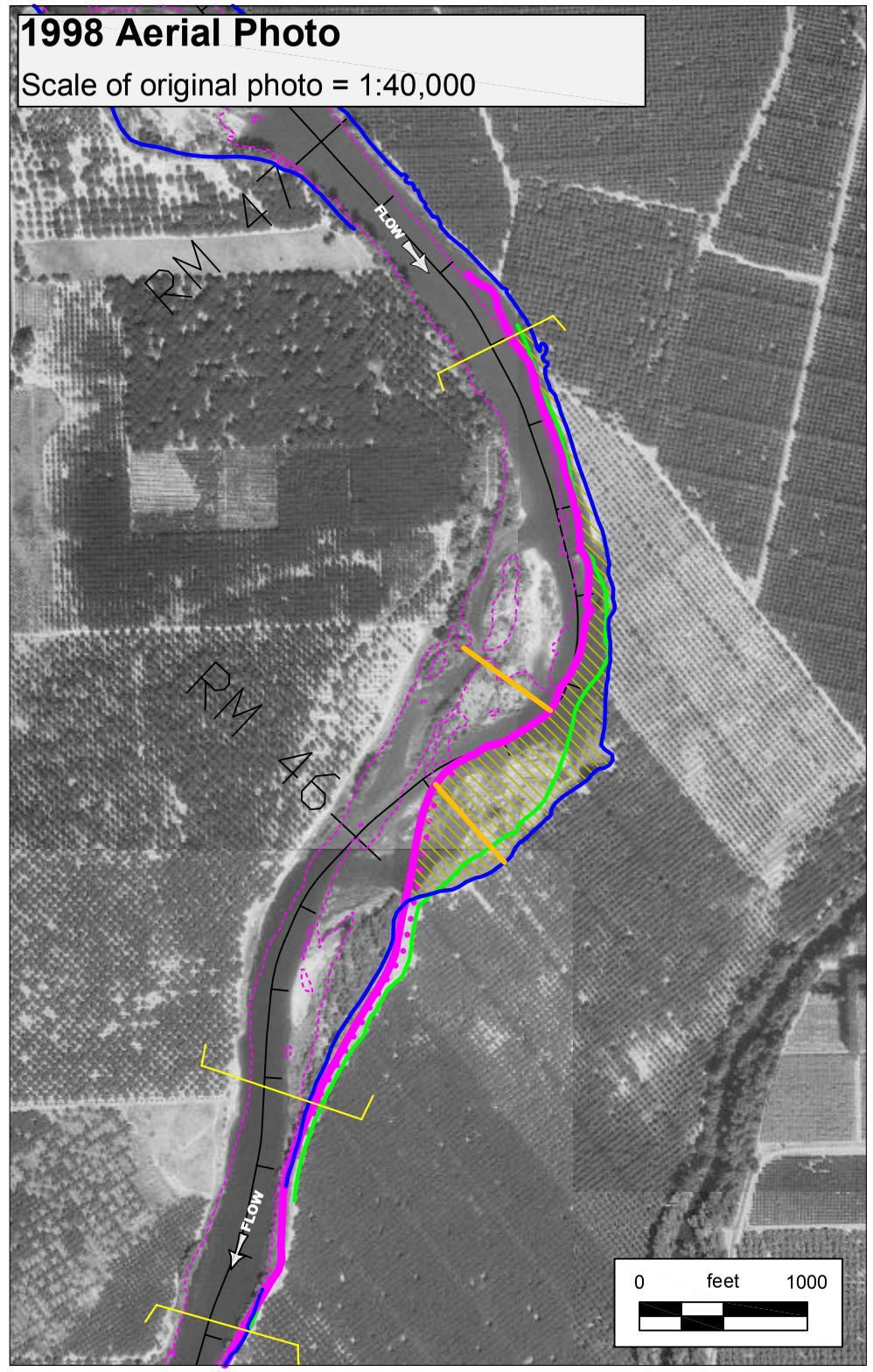
1967 Aerial Photo

Scale of original photo = 1:12,000



1998 Aerial Photo

Scale of original photo = 1:40,000



Water's Edge	Eroding Bank Edge	Levees
1909	1909	1909
1956	1956	1956
1967	1967	1967
1986	1986	1986
1998	1998	1998

- Erosion (pre-dam)
- Erosion (post-dam)
- Aggradation (pre-dam)
- Aggradation (post-dam)
- Maximum Erosion (pre- and post- dam)

RM_46.3, 12/4/2003 1:17:04 PM, Tabloid [11 x 17 in]

STATE OF CALIFORNIA
DEPARTMENT OF WATER RESOURCES

Oroville Facilities Relicensing
FERC Project No. 2100

SP-G2 Task 5B

Bank Erosion Study

River Mile 46.3
River-Left Bank

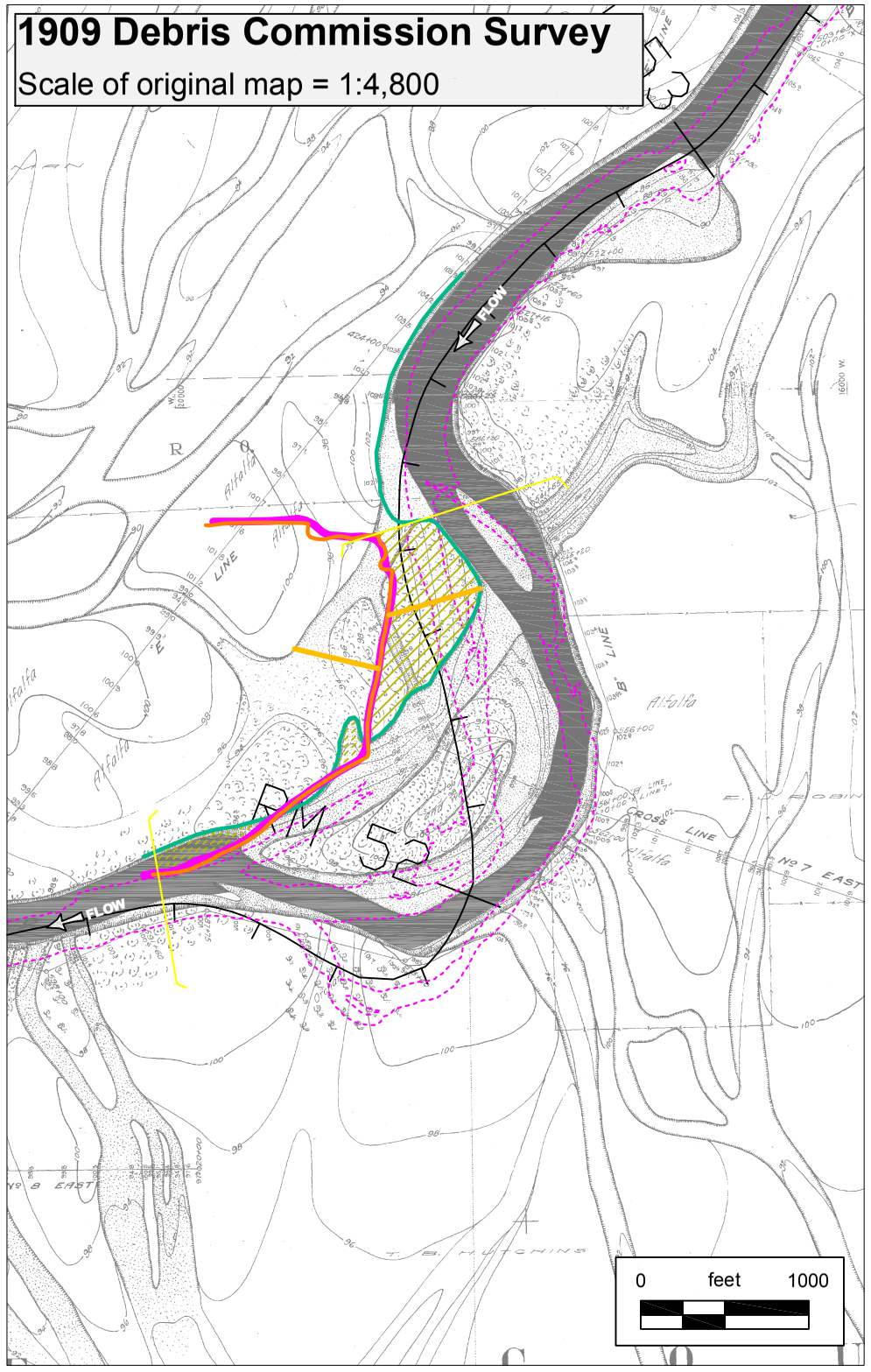
N

Prepared by: BB - DWR Central District

Date

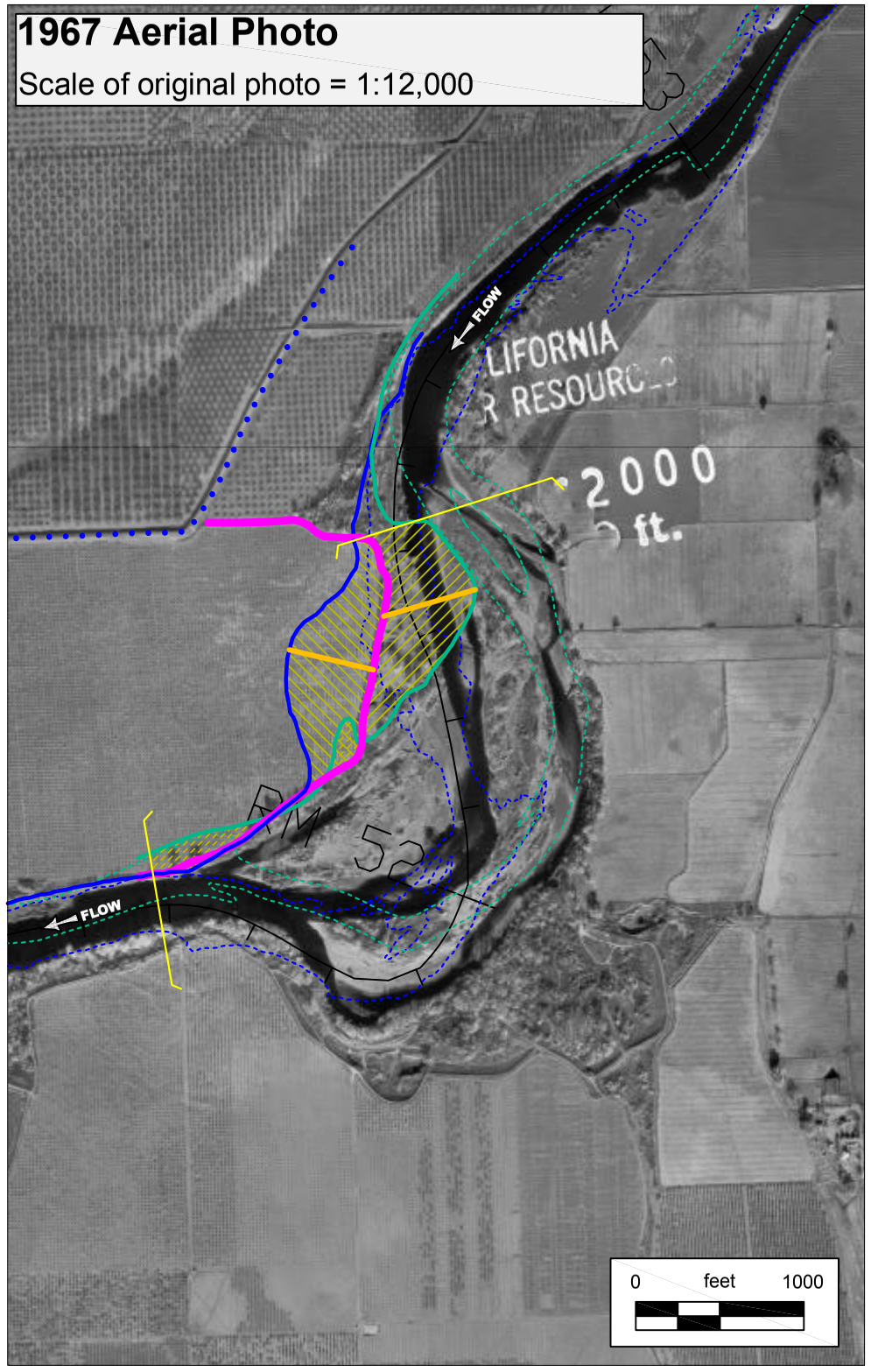
1909 Debris Commission Survey

Scale of original map = 1:4,800



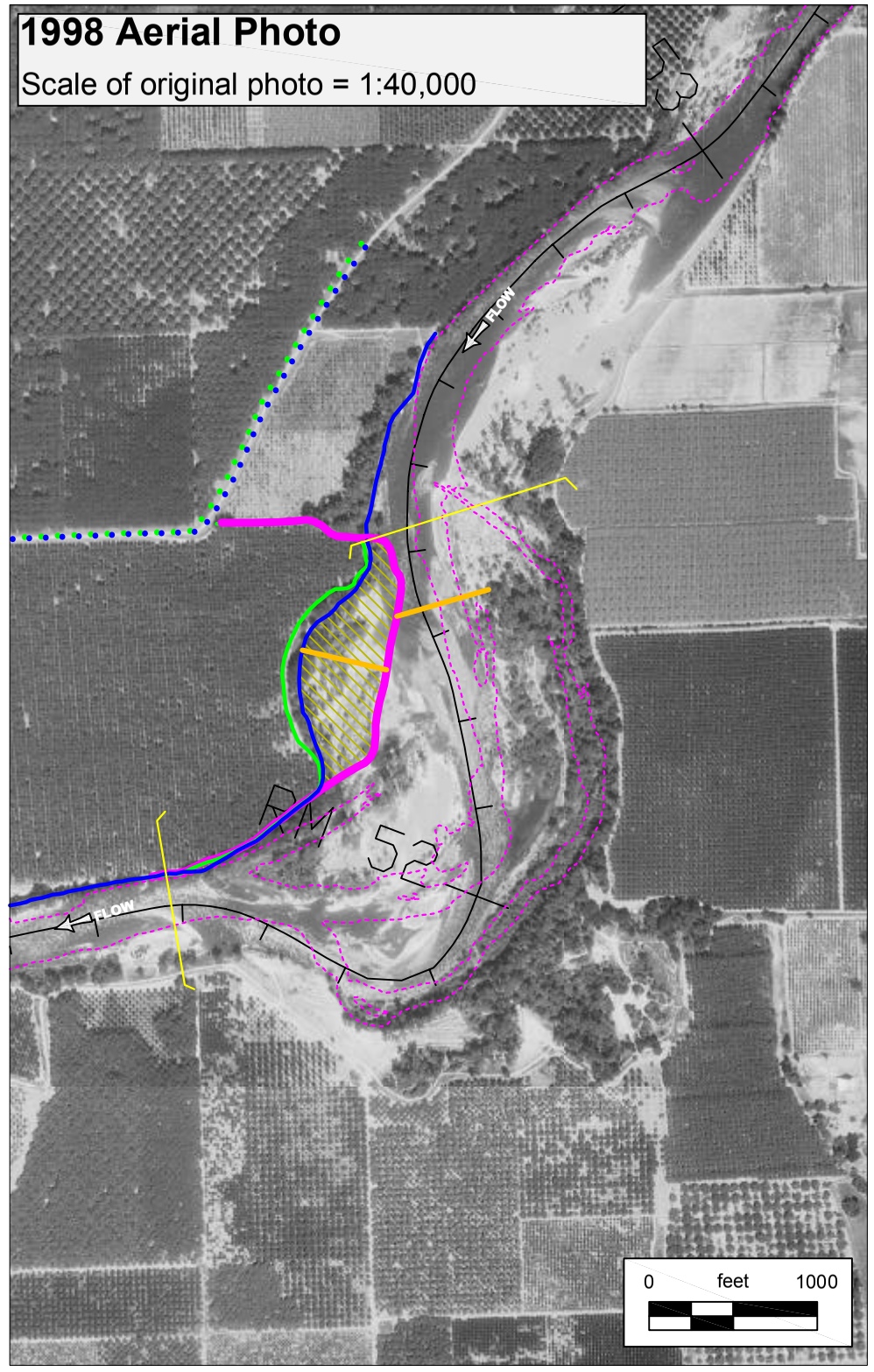
1967 Aerial Photo

Scale of original photo = 1:12,000



1998 Aerial Photo

Scale of original photo = 1:40,000



Water's Edge	Eroding Bank Edge	Levees
1909	1909	1909
1956	1956	1956
1967	1967	1967
1986	1986	1986
1998	1998	1998

- Erosion (pre-dam)
- Erosion (post-dam)
- Aggradation (pre-dam)
- Aggradation (post-dam)
- Maximum Erosion (pre- and post- dam)

STATE OF CALIFORNIA
DEPARTMENT OF WATER RESOURCES

Oroville Facilities Relicensing
FERC Project No. 2100

SP-G2 Task 5B

Bank Erosion Study

River Mile 52.3
River-Right Bank

N

Prepared by: BB - DWR Central District

Date

RM_52.3, 12/4/2003 1:29:16 PM, Tabloid [11 x 17 in]